# INCREMENTAL FINITE ELEMENT MODELING OF PROGRESSIVE DAMAGE IN LAYERED COMPOSITE MATERIALS

**Lingfu Zeng**

Aeronautics Division FFA
The Swedish Defense Research Agency
SE-172 90 Stockholm
Sweden
Lingfu.zeng@foi.se

This paper concerns with numerical modeling of progressive damage in layered materials. Some concepts that are necessary for a precise description of the path-dependent damage process, such as damage stability constraint, damage state, and damage function etc., are introduced. A unified criterion for both straight-ahead and kinking crack growth in a bimaterial is developed in terms of energy release rate and surface toughness. An incremental algorithm, which attempts to trace the damage development process, e.g. formation and growth of delamination and matrix crack, is proposed using an *h-p* finite element method. In connection to the algorithm, we describe an iterative remeshing procedure, which allows the initiation of new cracks and the growth of existing cracks, to search the damage state at every level of loading. Numerical example is given and the potential of extending the present work to composite structures of general 3D type, where delamination, matrix cracking, ply-jumping, fiber breakage and material degradation interact in a complex damage process, is addressed